Lecture.

GAS POISONING IN WARFARE: THE TASK OF THE MEDICAL SERVICE.[1]

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I WISH to direct your attention to-day to a consideration of certain problems connected with gas warfare which have to be faced by the medical services. I do not intend to deal in detail with the symptoms or the treatment of the individual case of gas poisoning, for I have no doubt that you are personally well acquainted with that aspect of the question; moreover, the information on this point has been summarized in pamphlets issued during the war, and has formed the subject of some of the lectures already given at this college.[2] What I want to do is to try and give you some idea as to what gas warfare really means to the forces in the field, and I am going to base my argument mainly on the number of the gas casualties that we experienced during the war, on the general character of those casualties and on their after-history.

For this purpose we may conveniently divide gas warfare as we experienced it at the hands of the Germans into the following stages:—

Period	Method of discharging gas	Gas used
April and May, 1915 (six attacks)	Cylinders ..	Chlorine.
April, 1915 to July, 1916 ..	Gas shell ..	Simple lachrymators, e.g., xylyl bromide.
December, 1915, to August, 1916 (five attacks) ..	Cylinders ..	Chlorine and phosgene.
July, 1916, to July, 1917 ..	Gas shell ..	Phosgene, diphosgene, chloropicrin, simple lachrymators.
July, 1917, to end of war ..	Gas shell ..	*Yellow cross:* mustard gas. *Green cross:* phosgene, diphosgene, chloropicrin, with in some cases chlorarsines. *Blue cross:* chlorarsines + large high explosive charge.
December, 1917, to May, 1918 (sixteen bombardments)	Projectors ..	Phosgene.

Without detailing the whole of the different gases which were used from time to time by the Germans, we may classify them broadly as regards their action on man into four groups, viz:—

(1) Acute lung irritants, such as chlorine, phosgene, diphosgene and chloropicrin, which cause, when breathed in sufficient concentration, the rapid onset of acute pulmonary œdema, death being due to interference with the respiratory function of the lungs owing to the accumulation of fluid and injury to the pulmonary alveoli.

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[1] A lecture delivered at the Royal Army Medical College, April 14, 1920.

[2] Medical Research Committee: 'Reports of the Chemical Warfare Medical Committee, Nos. 1 to 15. Haldane: JOURNAL OF THE ROYAL ARMY MEDICAL CORPS, xxxiii, p. 494, 1919. Barcroft: *ibid* xxxiv, p. 155, 1920.

(2) Simple lachrymators, such as xylyl bromide, which in low concentration lead to intense smarting and watering of the eyes, and on this account interfere with a man's fighting efficiency.

(3) Vesicants, such as mustard gas (dichlorethyl sulphide), which in low concentration causes intense conjunctivitis, chemical scorching and blistering of the skin, and severe injury and destruction of the mucous membrane of the trachea and bronchial tubes; death, when it occurs, being due almost invariably to secondary infection of the damaged and necrotic mucous membrane of the air passages with bacteria and the subsequent development of severe bronchopneumonia.

(4) Sensory irritants, such as the chlorarsines (diphenylchlorarsine, ethyldichlorarsine) which in minute concentration cause sneezing, intense burning and aching pain in the nose, mouth, throat and chest, smarting and watering of the eyes, nausea and great mental depression.

As a serious cause of casualties we may at once dismiss the simple lachrymators. When first they were used they had a considerable value as harassing or neutralizing agents, but owing to their high boiling point (xylyl bromide, for instance, boils at 185° C.) it proved impossible to obtain a high enough concentration of the vapour in the air to cause any material effects on the lungs or elsewhere in the body, whilst the slight conjunctivitis and intense lachrymation to which they gave rise passed off rapidly on withdrawing from the poisonous atmosphere. The number of men affected by lachrymators who actually reached medical units as casualties was quite small, and they were practically all returned to duty again in a couple of days: there were no deaths, save possibly in a few cases when lachrymator shell may have burst inside an occupied billet or shelter. It may be noted that gas shell containing lachrymator substances were discarded both by ourselves and by the Germans in the later period of the war when the progressive development of gas warfare led to the substitution of other chemical shell for the purpose of obtaining a harassing or neutralizing effect, so as to avoid the tactical disadvantages resulting from the high boiling point of the lachrymators and the consequent long persistency of these toxic liquids on the ground. The largest group of casualties resulting from lachrymator shell probably occurred during the battle of Loos, when some 550 cases were admitted to medical units.

Let us turn now to the effects produced by the acute lung irritant gases. You all know the story of the initial gas attacks made by the Germans between Langemarck and Hill 60 during April and May, 1915, Chlorine appears to have been the gas used, and it was liberated from cylinders installed in the German front line and was carried by the wind as a thick cloud upon the positions held by the French and ourselves. Great numbers of casualties were caused with a high death rate, but this is not to be wondered at, seeing that this new type of warfare came as a complete surprise, and our troops were consequently unprovided with respirators or other means of defence against the gas. Statistics as regards casualties are, I am afraid, unreliable in this instance, though there is evidence that some 7,000 gas casualties were admitted to our medical units. Many men were killed outright on the field by gas, but there are no precise data as to the number, whilst our casualty lists indicate that not less than 350 deaths occurred amongst

the gas casualties admitted to medical units. There is no need to dwell on the results of these early attacks, for, as I have said, our troops were quite unprotected, and it is of much greater importance to consider what happened in the later cloud gas attacks when defensive measures against gas had been evolved and the troops had been equipped with an efficient respirator.

Between December 19, 1915, and August 8, 1916, the Germans made five cloud gas attacks against us on the Wieltje, Hulluch, or Wulverghem Fronts. Instead of discharging the gas from cylinders at a comparatively slow rate, as had been the practice in the earlier attacks, they now released the gas in a limited time so as to attain the highest possible concentration of gas in the cloud, whilst they increased the toxicity of the cloud still further by mixing phosgene with the chlorine. What they were aiming at was clearly to surprise our troops with a lethal concentration of gas before they could protect themselves with their respirators.

The casualties that we suffered in these attacks were as follows :—

Total gas casualties resulting from cloud attacks between December 19, 1915, and August 8, 1916	4,207
Total deaths	1,013
Deaths per 100 casualties	24·0 per cent,

It speaks well for the general high standard of anti-gas discipline that the number of gas casualties was no larger, for an average of 850 casualties in each attack cannot be considered excessive when one considers the great number of men who must have been exposed to the cloud, seeing that gas was liberated all along sectors which varied in length in the different attacks from 1,700 to 4,400 yards, whilst in some of the attacks a dangerous concentration of the gas penetrated to a depth of 10,000 yards behind our front line.

How large a part is played by the element of surprise in these cloud gas attacks is well indicated by the fact that the great bulk of the casualties occurred in the front system of trenches, just where there is least opportunity to spread the warning in time for men to get on their respirators before the gas cloud is upon them. Thus in one of the attacks four battalions of one of the divisions actually holding the line suffered 320 gas casualties, and of these 232 occurred at points between 50 and 500 yards from the enemy, 185 taking place in the actual fire trenches. This is further borne out by considering where the deaths given in the table above occurred. These points were as follows :

	Number	Percentage of total deaths
In the trenches	485	47·8
In field ambulances	175	17·3
In casualty clearing stations	320	31·6
In hospitals on lines of communications	33[1]	3·3

You will see that nearly half the deaths occurred before the casualties could be admitted to a medical unit.

Though, no doubt, the number of casualties is not excessive if we compare it

[1] Note that twenty-eight of these deaths at hospitals on the lines of communication occurred as a result of the gas attack of December 19, 1915, before it was recognized that early evacuation of the cases to the base was prejudicial.

with the number of men actually involved in the attack, you must remember that these casualties are all caused within the space of a few minutes, and you will then get a better idea of the task that confronts the medical services in attacks of this nature. The number of casualties to be evacuated throws a great and sudden strain on stretcher bearers and on field ambulance units responsible for clearing the sector. The mortality figures in themselves are quite enough to show you that a large proportion of serious cases have to be dealt with. Even in the absence of further enemy activity the problem of rapid evacuation is difficult enough, and the difficulty is still further increased by the nature of the cases. What you have to fear is the onset of acute pulmonary œdema. If the case has been exposed to a heavy concentration of gas this œdema may come on at once, but as you know—and this is particularly the case in poisoning with phosgene or nitrous fumes—the onset of acute œdema may be delayed for an hour or two, the case very likely showing but trifling symptoms in the interval. When once œdema manifests itself it develops rapidly, and in quite a short time the case may be in the gravest condition. There is one thing in particular that will accelerate the onset of œdema and aggravate the symptoms when œdema is established, and that is muscular exertion, and it was for this reason that stringent rules were laid down in France enjoining that all casualties caused by the acute lung irritant gases, save the lightest cases, were to be evacuated lying down, so far as it was possible to do so.

In fatal cases of poisoning with chlorine or phosgene death in nearly every case occurs within the first forty-eight hours after exposure to gas, in fact more that eighty per cent. of the deaths may take place within the first twenty-four hours. The immediate aim of treatment must be therefore to tide the case over the initial critical period, and this implies that every effort must be made to get the casualties as quickly as possible to some place where effective treatment can be practised. The main essentials in treatment are complete rest, continuous oxygen administration, and in appropriate cases venesection, and the casualties require constant attention and nursing in the critical period. In France we found that as a rule the best plan was to get the cases back to the casualty clearing stations for treatment, but sometimes field ambulances were so fortunately situated as to have facilities for the effective treatment of these cases, and the distance that the casualty had to be transported by ambulance car could then be somewhat curtailed. Had suitable apparatus been available it would have been a good thing to have kept up oxygen administration to the bad cases during transportation.

You will see that it is no easy task to deal successfully with a large batch of severe gas casualties resulting from a cloud gas attack. Evacuation may be interfered with by shell fire, and perhaps have to be delayed till nightfall owing to the sector affected being under enemy observation during the day. Moreover accommodation in the medical units may be already strained owing to a heavy influx of other battle casualties. The British, however, were not the only ones who had to try and meet these difficulties. The Germans had a bitter experience of the effects of chlorine and phosgene, for when we had developed our own organization for the offensive use of gas our special companies carried out numerous cloud and projector attacks with these gases, and the following passages quoted from German instructions regarding the diagnosis and treatment

of gas poisoning, which were published in May, 1918, lend emphasis to what I have already said.

"Definite cases of gas poisoning are harmed by any form of transport, since this leads to unavoidable muscular exertion. . . . On the other hand, the choice of the time for transport is often determined by military considerations, and the ultimate fate of the casualty depends on appropriate treatment and, above all, on trained nursing, which is best afforded in the gas station of a permanent hospital. An attempt should therefore be made to transfer the case from the medical dug-out to a gas station within an hour or two of being gassed. If the case is only taken as far as the main dressing station a decision has to be made whether further transport or the lack of efficient nursing constitutes the greater danger. . . . The value of a gas casualty station in an army field hospital rests on the fact that experienced medical officers, detailed organization of the hospital, and, in particular, a thoroughly trained male and female nursing staff alone render it possible to do justice to individual gas cases and to attain favourable results, especially when there is a great influx of cases."

Projector discharges caused results which were in the main similar to those produced by cloud gas attacks, though the total casualties resulting from any one discharge were much smaller owing to the more limited area affected by the attack. This method of gas attack was British in development, and consists in the simultaneous discharge on to a selected target of a large number of heavy bombs filled with liquid phosgene from trench mortars of simple type. The Germans made but little use of this method, and their sixteen projector attacks between December, 1917, and May, 1918, only caused us 444 casualties, of whom 81 died, the death-rate being 18·2 per 100 casualties. These figures, however, hardly give a fair picture of the possibilities of this mode of warfare. Our own projector bombs held twice as much gas as those of the Germans, and that our methods were effective is well shown in the case of one of our projector attacks as a result of which we caused the enemy 119 gas casualties, of whom fifty-three died, and this in spite of the fact that the installation of gas had been suspected and the troops had been specially warned to be on the alert. You can well understand a result like this when you think how well adapted this method is for surprising the enemy with a very heavy concentration of gas.

After August 8, 1916, the Germans never made another cloud gas attack upon us, though they continued to use this method on other parts of the Western Front up to July, 1917. Very likely they were deterred from doing this by the fact that they could only count on a favourable wind for a brief period in the spring, as well as by our raiding activity and the heavy character of the fighting. On July 15, 1916, shortly after the first battle of the Somme commenced, they introduced shell containing acute lung irritant substances, and the employment of shell and trench mortar bombs containing such substances as phosgene, diphosgene and chloropicrin rapidly became extensive.

Between July 15, 1916, and July 12, 1917, the number of casualties caused by these shell who were admitted to medical units was as follows:—

Total gas shell casualties, July 15, 1916, to July 12, 1917	8,806
Total deaths	532
Deaths per 100 casualties	6·0

When you consider that this period embraces the battles of the Somme, Arras and Messines you will recognize that the gas shell casualties formed but a trifling fraction of our total battle casualties. The comparatively small number of casualties, and the lowness of the mortality in spite of the great number of gas shell used, owes its explanation to the fact that it is difficult by this method to attain a sufficient concentration of acute lung irritant gases to be really effective before the troops exposed to the shelling have got on their respirators or gained protection in dug-outs, and in agreement with this one may note that in many instances the only severe casualties resulting from these bombardments occurred right at the commencement of the shelling when men were caught unawares by shell bursting close to them before they had time to appreciate the nature of the bombardment. The method cannot therefore be regarded as of great value for producing casualties, however great may be its harassing or neutralizing power. The problem of handling the casualties was evidently far easier in this case than after a cloud gas or projector attack, the more so as the gas shell bombardments were frequently directed on targets behind the trench system, such as batteries, roads or billets, from which places rapid evacuation of the gas casualties to medical units was as a rule a simpler problem than evacuation from the trenches.

With the introduction of two new types of gas shell on July 13, 1917, we reached the culmination of the German methods of offensive gas warfare. From this date until the end of the war three kinds of gas shell, distinguished from one another by the characteristic identification marks painted on the shell, were employed by the Germans in enormous numbers. These shell were: (*a*) Yellow cross shell, containing dichlorethyl sulphide or mustard gas, (*b*) green cross shell, containing acute lung irritant substances, (*c*) blue cross shell, containing toxic chlorarsine compounds in addition to a heavy high explosive charge.

During the period July 13, 1917, to the end of the war we suffered the following gas shell casualties :—

Total gas shell casualties, July 13, 1917, to end of war ..	160,526
Total deaths	4,086[1]
Deaths per 100 casualties	2·5[1]

Here we get an astounding change in the results produced by gas warfare. The number of gas casualties has become enormous, though the mortality amongst these casualties is surprisingly low. Gas in fact accounted during this period for some fourteen per cent of our total battle casualties. The change is to be attributed practically entirely to the introduction of mustard gas, for this poison was responsible for not less than eighty per cent of our total gas casualties during this period. In support of this statement let me quote the experience of two medical units, the one a corps gas centre, the other a hospital at one of the bases. Between May 25 and October 9, 1918, the corps gas centre admitted 3,510 gas casualties: of these 83·4 per cent were caused by mustard gas, 9·6 per cent by blue cross, and 7·0 per cent by green cross. The hospital at the base admitted

[1] Exclusive of the small proportion of deaths that occurred amongst the casualties after evacuation to England.

894 gas casualties between May 1 and August 31, 1918, and of these 77 per cent were ascribed to mustard gas, 10 per cent to blue cross, 6 per cent to green cross, 4 per cent to lachrymatory gases, the remaining 3 per cent not being defined.

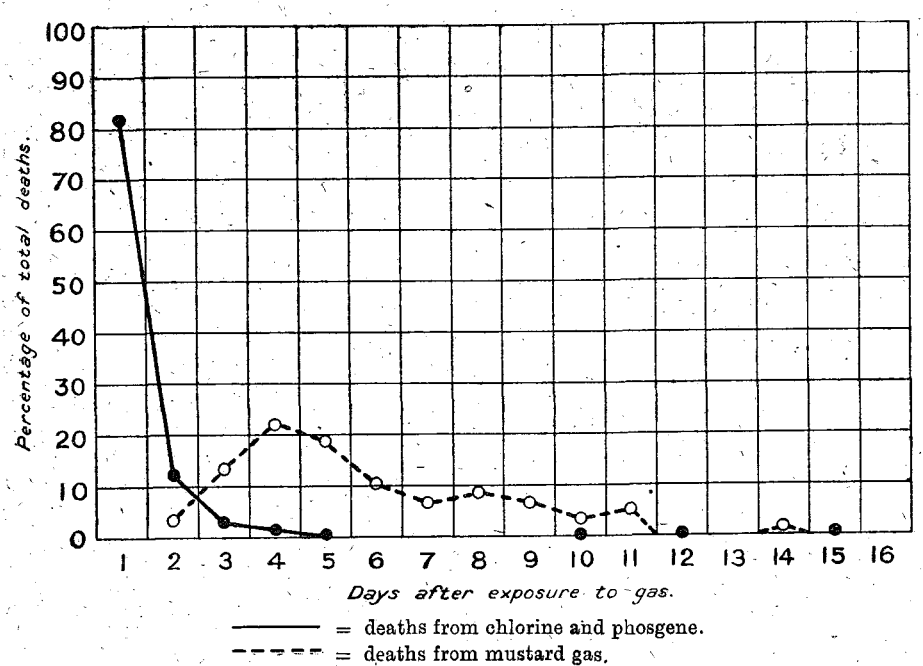
The great number of the casualties is easily accounted for by a consideration of the properties of mustard gas. Its action is insidious, for it has little smell and causes no immediate sensory irritation of the eyes or respiratory passages, the onset of inflammatory changes in the eyes, skin and respiratory passages being delayed as a rule for an hour or two and coming on gradually. At the same time it is intensely toxic in very low concentrations, and as the boiling point of the liquid is 217° C. ground which has been shelled continues to yield a dangerous concentration of the vapour for days. The high boiling point and slow vaporization of the liquid have, however, one advantage, for it means that some time is required for a man to absorb enough of the poison to be affected dangerously, and there is therefore a reasonable probability that he will have withdrawn from the dangerous area or protected himself before this happens, even if he has unwittingly entered an area contaminated with mustard gas owing to previous shelling. Remember, however, that the standard of anti-gas discipline was high throughout the whole of the mustard gas period; had it not been for this the picture would have been very different. To emphasize this I need only quote one purely local instance when anti-gas precautions were grossly neglected both during and after a mustard gas bombardment; nearly fifty per cent of the casualties caused on this occasion died. You need no better example to show you how much depends on good defensive organization against gas.

When one is dealing with the acute lung irritant gases one is apt to gauge the effectiveness of the weapon in terms of its killing power, owing to the large proportion of severe casualties and the high death-rate that are liable to occur. We must evidently regard mustard gas in a different light. In this case the value of the poison lies in its casualty producing power, for its killing power cannot be reckoned great amongst troops well skilled in defence against gas. The principal difficulty that confronts the medical services is therefore the question of handling this great number of casualties.

Owing to the slow onset of the symptoms after exposure to the gas, the problem of evacuation is a good deal simpler than in the case of poisoning with the acute lung irritants, and cases can safely be transported to a far greater distance behind the line than is advisable when acute pulmonary œdema is likely to supervene. Moreover, there is no necessity to lay such stress on the importance of evacuating the casualties as lying cases: in fact the great majority of the casualties can in practice be regarded as walking cases, at least in the earlier stages when their vision is not seriously interfered with by the conjunctivitis. On the other hand, there are some troublesome features in the treatment of mustard gas casualties that throw a good deal of additional work on the medical units, especially in the forward area. It is imperative that clothing contaminated with mustard gas should be replaced and disposed of at the earliest possible moment, lest a mild case should be transformed into a grave one owing to continued absorption of the poison; and arrangements have to be made to bathe the cases at the same time. At a somewhat later stage when conjunctivitis has developed, frequent irrigation of the eyes is necessary till the acute inflamma-

tion begins to subside, and steps must be taken to minimize the risk of septic infection of any burnt or blistered areas of the skin, both of which measures mean a good deal of attention on the part of the nursing staff.

It is only in rare cases that the damage caused by mustard gas is in itself sufficient to cause death. A fatal issue is almost always determined by secondary infection with micro-organisms of the necrotic mucous membrane of the trachea and bronchial tubes. Bronchopneumonia caused in this way takes time to develop, and the subsequent fate of the patient depends on the virulence of the infection and on his own powers of resistance, but when once bronchopneumonia supervenes the outlook for the case must be regarded as serious. The deaths therefore are not crowded into the first couple of days after exposure to gas, as is the case in chlorine or phosgene poisoning: they do not begin until twenty-four to thirty-six hours have elapsed after exposure, and continue to occur for many days, and sometimes in fact weeks, though the majority of deaths take place within the first ten days. The accompanying figure shows very clearly the difference between chlorine or phosgene poisoning and mustard gas poisoning in this respect.



The curve representing the deaths after chlorine and phosgene poisoning is based on 424 fatal cases resulting from three cloud gas attacks, whilst that indicating the deaths from mustard gas is based on fifty-nine fatal cases which occurred amongst a group of particularly severe casualties resulting from a single heavy bombardment with yellow cross shell.

During the mustard gas period less than ten per cent of the gas casualties could be attributed to the action of green cross shell, and there is no reason to

believe that the mortality amongst these casualties was any higher than in the period July, 1916, to July, 1917.

Blue cross shell were almost as ineffective as casualty producers, and the chlorarsines contained in them were not responsible for any deaths. These shell were introduced by the Germans with the idea that the distressing irritant symptoms which make their appearance very rapidly on exposure to air in which these chlorarsines have been disseminated would be sufficient to put men temporarily out of action, and so render them an easy prey to some other more lethal gas as well as less capable of withstanding an attack. In addition the Germans hoped that these toxic substances would penetrate our respirator, a hope that was not realized. As harassing agents blue cross shell undoubtedly had some value, and hampered troops by causing them to wear their respirators, but even if a man was put out of action for the moment by the irritant effects, these had in most cases almost entirely vanished by the time he reached a medical unit. Many of such cases, though no doubt severely affected at the time, could be returned to their units fit for duty within a day or two after admission to a medical unit in an army area. So transitory were the symptoms that many men never left their units at all. Nothing really definite in the way of after effects could be made out with certainty in the cases of blue cross poisoning that reached the base.

The mild character of the blue cross casualties prompts me to speak of a difficulty that medical officers in army areas were continually being called upon to face. The gravity of a severe case of phosgene poisoning, in whom pulmonary œdema has already developed, is immediately apparent, and any case of mustard gas poisoning affords objective evidence which permits of a correct diagnosis. Many cases of alleged gas poisoning, however, reach medical units with little or nothing to show in the way of symptoms of gassing; and there is always the possibility that some of these men have never been exposed to gas at all. How are you to deal with these cases? Careful examination, in the hopes of eliciting some evidence of gassing, and the patient's story as to what happened, may throw light on the case provided that you are thoroughly acquainted with the effects produced by the different warfare gases. A rule that could be safely applied in France was to detain any case that appeared in the least doubtful for forty-eight hours; if no definite objective symptoms had developed at the end of that time, one could be confident that not more than an insignificant dose of gas had been absorbed by the case, and the man could speedily be returned to duty. One must necessarily err on the side of caution in these cases, even at the risk of countenancing a few malingerers, for there is always the possibility that the case one is dealing with may prove to be a delayed case of poisoning with an acute lung irritant gas. A note by the regimental medical officer as to the nature of the shelling may be invaluable in these cases. It is most desirable that trivial cases of gas poisoning should not be evacuated from army areas, if the military situation permits their retention, so as to avoid the inevitable delay that must otherwise occur before the man can be returned to duty. The "N.Y.D. Gas Centres," which were established in France in army areas, proved themselves extremely valuable in this connexion.

Up to this point I have been dealing with the problem of gas poisoning as it is presented to the medical services in army areas in the vicinity of the battle

zone. There is, however, another and most important aspect of the question which arises, in the main, in hospitals on the lines of communication remote from the battle front, and in permanent hospitals and convalescent depots where cases are retained until their treatment is completed; and I want to put before you some general features in the after-history of the gas casualties evacuated from army areas, and call your attention to the question of invalidism from gas poisoning.

Since neither the simple lachrymators nor the chlorarsines, as we experienced them in France, gave rise to material disability, we may confine ourselves to the question of poisoning with the acute lung irritants and with mustard gas.

Those who survive the initial critical stage of pulmonary œdema caused by chlorine or phosgene have a very good prospect of ultimate recovery. Secondary bronchopneumonia is quite uncommon in these cases. One might expect that so severe an inflammatory condition in the lungs would be followed by some lasting pulmonary disability such as chronic bronchitis. While this is true of a certain number of the casualties, it does not constitute a serious cause of disability. By far the most common after-effect is the "irritable heart syndrome," associated with undue breathlessness on exertion and a liability to abnormal frequency and shallowness of the breathing—though physical examination of the chest reveals no definite abnormalities in heart or lungs. These symptoms have been recently discussed in detail by Haldane,[1] who has pointed out how large a part is played by neurasthenia in these cases. The length of the disability caused by the symptoms of "irritable heart" varies a good deal, and much depends on the skill with which these cases are handled when once the condition has developed. Experience in France led us to believe that the mildest cases of chlorine or phosgene poisoning could be returned to duty within one to two weeks, whilst there was a reasonable probability that two-thirds of the remainder would recover completely within two months. It does not follow by any means that those who have been most severely affected in the acute stage are necessarily the ones to be incapacitated for the longest time, for a number of cases are known in which men were on the border line of death in the acute stage of poisoning, and yet became fit for duty again in four or five months, and rejoined combatant units in the various theatres of war.

When mustard gas was first introduced, we undoubtedly exaggerated its invaliding power, for the multiplicity of the symptoms and the entire absence of knowledge as to possible after-effects naturally led to the gravity of the condition being over-estimated. In the first few months of the mustard gas period almost sixty per cent of the gas casualties were evacuated to England, and the majority of the cases retained in France for treatment were absent from duty for from six weeks to three months, but as the novelty of the situation wore off much better results were obtained.

From the spring of 1918 onwards a very careful investigation of the question was made in the Boulogne area under the influence of Colonel T. R. Elliott, C.B.E., D.S.O., F.R.S., the consulting physician to that base, with the co-operation of many medical officers at the different hospitals and convalescent depots. They set out to ascertain whether the period of invalidism could be materially curtailed

[1] Haldane, loc. cit.

without detriment to the cases, and modifying and improving treatment in the light of their experience of the previous months, they obtained the most gratifying results. In mustard gas cases the neurasthenic element enters extensively into the picture, and it was the recognition of the true part played by this that contributed largely to the improvement in the results. Firm control of the patients from the start, and the restriction of the period of detention in hospital to a minimum, prevented the cases from falling into a morbid condition and developing those functional symptoms which so often delay convalescence, effects which tend to be exaggerated by prolonged treatment in hospital.[1] From May, 1918, onwards, the evacuation to England of cases from the Boulogne area never exceeded twenty-five per cent of the admissions, the remainder being retained in France till fit for duty. Of those retained many were cured within four weeks, and practically all within eight weeks, and better and better results were obtained as the year went on. Severe chest trouble and extensive burns were the most serious factors leading to prolonged disability; not more than ten per cent of the cases whose eyes were affected sustained a degree of corneal injury which was sufficient in itself to require invalidism for more than six weeks. That the restriction of hospital treatment was justifiable was shown by examining the records of the convalescent depots to which the cases were transferred from the hospitals, for the number of cases who had to be readmitted to hospital was extremely small (see the table below); in the case of one such convalescent depot the average time intervening between exposure to gas and transference to base details as fit was 40·3 days in the case of men who had suffered from material skin burns, and 33·2 days in the case of those who had not.

Though the question of invalidism was particularly investigated in the Boulogne area, and the best results obtained there, the disposal returns for all hospitals on the lines of communication showed a general improvement in the results obtained in the last few months of the war over those obtained in 1917, in spite of the fact that there was no indication of lessening in the general severity of the cases. This is shown by the following figures:—

DISPOSAL OF GAS CASUALTIES FROM HOSPITALS AND CONVALESCENT DEPOTS ON LINES OF COMMUNICATION IN FRANCE.

Hospitals	Sept. and Oct., 1917	Sept. 9—Oct. 26, 1918
Total number of cases dealt with	16,839	24,642
Died	0·9 per cent	1·1 per cent
Evacuated to England	53·5 ,,	28·1 ,,
Returned to duty	2·3 ,,	2·6 ,,
Transferred to convalescent depot	24·4 ,,	50·4 ,,
Remaining at end of period	18·9 ,,	17·8 ,,
Number evacuated to England as percentage of cases actually disposed of	66·0 ,,	34·1 ,,
Convalescent Depots		
Total number of cases dealt with	7,409	17,529
Returned to duty	56·1 per cent	65·9 per cent
Readmitted to hospital	2·1 ,,	3·4 ,,
Remaining at end of period	41·8 ,,	30·7 ,,

[1] Wilson and Mackintosh (*Quart. Journ. Med.*, xiii, p. 201, 1920) have given a very complete account of their experience with mustard gas cases at No. 7 Stationary Hospital, and this affords an admirable instance of the way in which appropriate treatment based on a recognition of the true significance of the different symptoms may accelerate recovery.

Naturally there was a good deal of variation in the results obtained at the different bases. Thus in September and October, 1918, when the cases evacuated to England formed 34·1 per cent of the cases disposed of from all hospitals on the lines of communication, Boulogne showed a figure for this ratio of 19·4 per cent, Rouen of 40·5 per cent, and Etaples of 62·1 per cent; but even if we subtract the Boulogne figures the ratio for all other bases is 42 per cent, i.e., a great diminution below what took place in 1917. You must, however, bear one fact in mind in considering these figures. The ease with which casualties can be retained in medical units on the lines of communication must depend largely on the military situation at the time, and a heavy influx of battle casualties may compel the transference of even comparatively mild cases to more distant hospitals so as to avoid undue congestion, though under quieter conditions such cases might without difficulty be retained till completely cured.

While results in France were showing this steady improvement, there is reason to think that the results in England were not nearly so good. From such statistical evidence as I have seen the period during which gas casualties evacuated to England were classed as unfit for duty might be reckoned in months rather in weeks, and even if we assume that these casualties were on the whole of a more severe character than those retained for treatment in France, the experience at Boulogne would seem to indicate that this period of invalidism was excessive. I feel sure that far better results would have been obtained when the careful investigations made in the later months of the war had been fully appreciated. The pamphlets on the diagnosis and treatment of gas poisoning issued by the Director-General of Medical Services in France mainly treated of conditions in the early or acute stage, for that after all was the immediate problem that faced us in France, and it required months of patient investigation to reveal the after-effects of acute lung irritant or mustard gas poisoning in their true proportions. The pamphlets in themselves would, I think, tend to give an exaggerated idea of the severity of gas cases as a whole to medical officers who had not had the opportunity of seeing personally cases of all degrees of severity in the earlier stages after gassing, and this serves to show how important it is to obtain and to circulate all the information possible if you are to obtain the best results.

Finally may I ask you to consider for a moment or two the general significance of the facts I have laid before you. Poisonous gas as an offensive weapon was not introduced by the Germans until the ninth month of the war, and the new weapon was subsequently developed slowly in a series of progressive stages. We must, I suppose, still regard gas warfare as in its infancy, for we have touched only the fringe of the resources of the chemist, and as research increases our knowledge of toxic substances and new methods are devised for the liberation of these poisons the effectiveness of gas warfare may easily be increased far beyond what we experienced during the war. We have at least gained an insight into the possibilities of this new development in warfare. It would clearly be wrong for us to regard the poisonous substances used in warfare merely as killing agents, for temporary disability, be it for a brief period as was the case with the lachrymators or chlorarsines or for a longer period as was the case with mustard gas, may be quite sufficient to allow some military object to be gained. The medical services must be prepared to meet any of these conditions.

We started the war with hardly any knowledge of the effects of the poisonous gases that we were called upon to face in the field; such information as there was had been derived from cases of accidental poisoning in mines, sewers, chemical works and the like, and the scanty data were unknown to the great majority of medical men. Knowledge regarding some types of gas poisoning has now been gained by bitter experience, and the lesson that we have learned ought never to be forgotten. An entirely new type of battle casualty has now to be reckoned with in modern warfare, one whose treatment falls within the province of the physician rather than the surgeon. I cannot forecast the lines along which gas warfare may develop in the future, but of this I am convinced—unless the medical services keep abreast of the development of modern science they will run the gravest risk of being found wanting in a future war, and I should like to plead here for the closest liaison between the medical and gas services.

Under the present arrangements the responsibility for general defensive organization against gas or other poisons used for offensive purposes does not rest with the medical services, and they are therefore free to centre their attention on the clinical and therapeutic aspects of the question. As the progress of chemistry suggests new modes of offensive warfare, physiology and pathology must form the basis for rational treatment of the casualties that may result. The saving of life and the relief of suffering are the immediate objects of the medical services in time of war, but you cannot hope to attain success in this unless you are completely conversant with the nature of the pathological changes and with the significance of these changes to the organism. Remember that it is by no means easy to deduce from experiments in the laboratory the precise effects that may be caused by gases in the field under war conditions; you must try and weigh experimental evidence in the light of the experience we have gained during the war. You must not limit yourself to the treatment of the individual case; you must take a broader view than this, and review carefully the significance of gas warfare to the forces in the field as a whole, and consider how the Medical Services can best fulfil their function. That is why I have put before you numerical data regarding the casualties, deaths and disability caused by gas poisoning during the war. The figures in themselves are quite enough to show you the magnitude of the problem. You can judge from these how great are the demands made on medical organization, what provision is necessary for adequate accommodation and suitable equipment in medical units, and how carefully effective methods of handling and transporting the casualties must be thought out.

I have deliberately laid some emphasis on the duration of invalidism, for this is, I think, a side of the question to which too little attention is apt to be paid. Excessive length of hospital treatment is undoubtedly bad for the cases, and implies an undue burden on hospital accommodation and on the medical and nursing staff. The strain involved in modern warfare affects not only the troops at the seat of war but the whole nation as well, and the ability to maintain the numbers and quality of the fighting troops without prejudicing the other necessary activities of the nation may become the crucial factor. Wastage due to casualties is bound to be great, and reduction to a minimum of this wastage may well prove decisive. I have tried to give you some idea of the extent to which careful investigation showed that wastage due to gas poisoning could be cut

down by reduction of the period of invalidism. Investigations of this character are of the utmost importance and should receive every encouragement, but if full value is to be obtained from the results it is essential that the information should be disseminated widely and without delay to all medical officers likely to be concerned with the casualties.

Report.

NATIONAL HEALTH SERVICES.[1]

Novel Scheme of Re-organization.

The Consultative Council on Medical and Allied Services which is associated with the Ministry of Health and was appointed in October last, was invited by Dr. Addison on its formation to consider the problem of forming a systematized medical service established on a local basis but applicable area for area to the whole country. The Council, of which Lord Dawson of Penn is the Chairman, has now issued an Interim Report, not indeed as a final exploration of so large and complicated a subject but rather as an indication of the trend of its deliberations and conclusions up to date. The Report is issued now "in view of the urgency which attaches to the orderly building of a constructive health policy and the close relationship which exists between medical services and problems connected with the Poor Law and Local Government."

The Council begins its Report with a brief description of the failure of the present organization of medicine to bring the advantages of medical science within reach of the people. Medical treatment while becoming more effective tends at the same time to become more complex. This tendency is exemplified in the modern handling of such complaints as appendicitis and tuberculosis. As the complexity of treatment becomes greater, it grows increasingly difficult for the individual practitioner to administer the full range of treatment, requiring, as it does, access to such resources as those of bacteriology, biochemistry, radiology and electrotherapeutics, while the number of patients who can afford to pay for it diminishes. Public opinion again appreciates more and more that the home does not always afford the best hygienic conditions for recovery from serious illness. The Council lays it down that any scheme of medical service must be open though not necessarily free to all classes of the community; that it must be such as can grow and expand and adapt itself to varying local conditions, and that in each locality it must comprise and provide for all the medical services, preventive and curative, necessary to the health of the people, all these agencies being brought together in close co-ordination under a single health authority for each area.

At the centre of the medical service of the country lies the treatment which

[1] Interim Report by the Consultative Council on Medical and Allied Services associated with the Ministry of Health.